

National Aeronautics and  
Space Administration

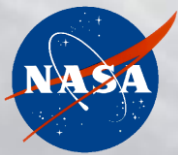
**Jet Propulsion Laboratory**  
California Institute of Technology  
Pasadena, California

# AIRS Calibration Status

**Steve Broberg**

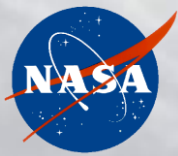
**Inputs from George Aumann, Tom  
Pagano, Evan Manning**

**April 27, 2018**



## Calibration change categories

- **Operational - A/B detector changes**
  - *2104 channels have redundant A & B detectors*
  - *there have been occasional table uploads to restore/improve/optimize degraded channels*
- **Level 1B PGE changes**
  - *Last change in implementation of L1B was v5*
- **Calibration coefficients**
  - *2378 AIRS channels with individual calibration coefficients - unchanged since launch*
- **L1C cleans L1B irregularities, but is not a new calibration**
  - *(although Evan has experimented with it)*



National Aeronautics and  
Space Administration

Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

## Number of AIRS channels with $NE\Delta T < 1K$

### Table Loads

2003-01-10

2003-11-18

2012-01-21

2013-06-10

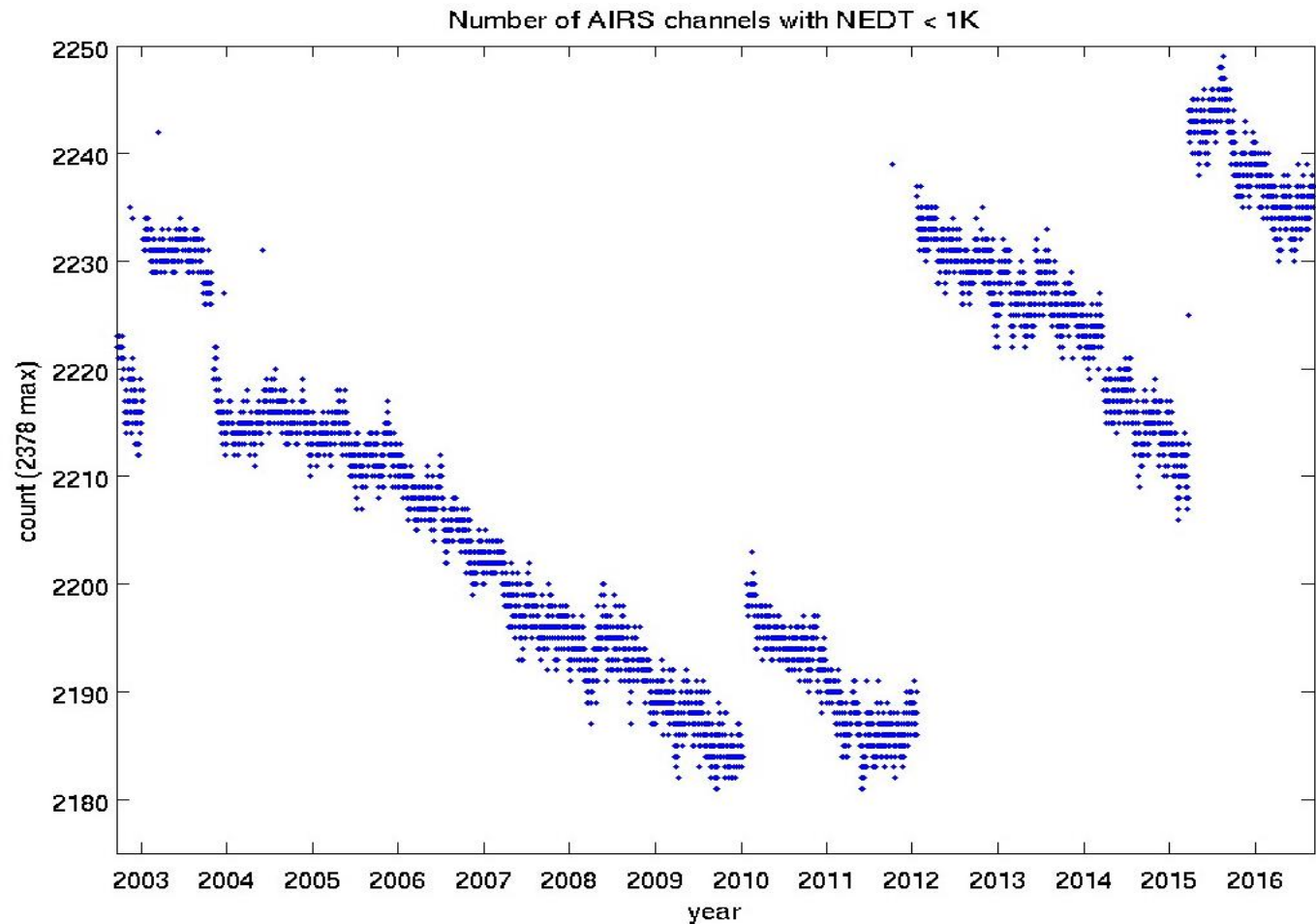
2015-03-23

### Instrument Events

2003-10-29 Solar Flare  
safety shutdown

2010-01-09 28V SEU

2014-03-22 Cooler A  
59K  $\rightarrow$  68K





National Aeronautics and  
Space Administration

Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

## Level 1B PGE implementation

- **Changes ready to go**
  - *Increase precision of radiances*
  - *Spectral estimate per granule (Bob Deen version)*
  - *Spectral estimate per scan (Strow model)*
- **Changes to be implemented (partial list)**
  - *New NEN calc (3 granules)*
  - *Non-gaussian noise characterization*
  - *Offsets per scan*
  - *Pop/moon detection dynamic thresholds*
  - *Clear, SO<sub>2</sub>, and dust flags (new algorithms)*
  - *C<sub>ij</sub> – improve metrics*

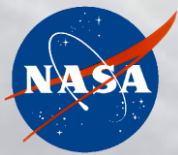


# L1B Calibration Coefficients

## V5 is good to 100-200 mK

- What is referred to as V5 L1B includes no changes to the fundamental calibration coefficients – there have been no changes since the at-launch version.
- Numerous comparisons of the AIRS data using various techniques:
  - a) clear(obs-calc) by Strow
  - b) SNO compared to IASI (Tobin)
  - c) DomeC compared to CrIS and IASI (Aumann)
  - d) TSNO compared to CrIS (Manning)
  - e) AIRS compared to MODIS (Wang)
  - f) AIRS compared to CrIS (Wang)
  - g) Random nadir sampling compared to CrIS (Aumann)
- On average, agreement is good
- The AIRS calibration looks good at the 100 mK level under temperature conditions between 200K and 350K (uniform window scenes).
- The calibration is stable at 0.3 mK/yr at  $1231\text{ cm}^{-1}$  relative to the SST.



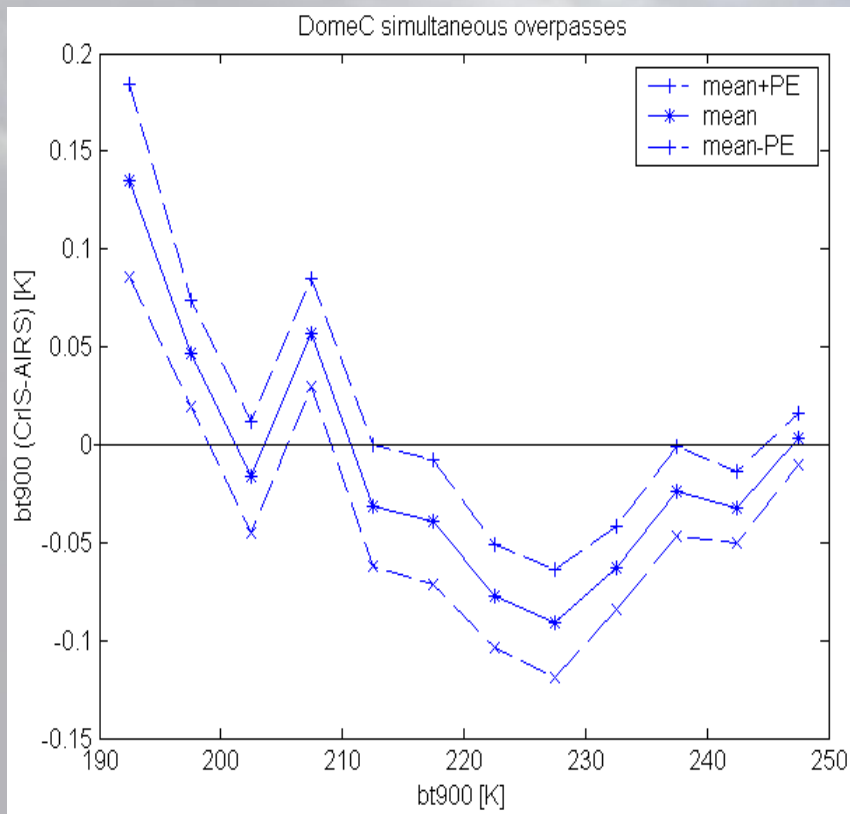


National Aeronautics and  
Space Administration

Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

# L1B Calibration Coefficients Variability Seen with Scene Temp

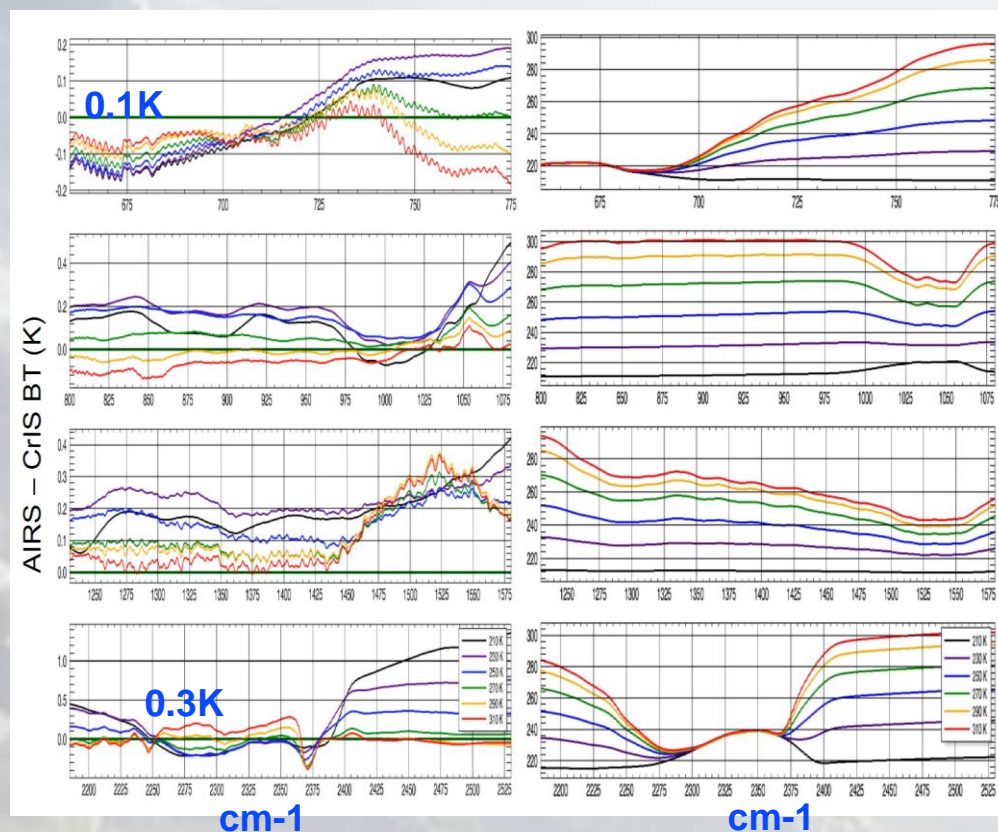
## CrIS-AIRS 900 $\text{cm}^{-1}$ Brightness Temperature Difference for SNOs at Dome C (Aumann)



## AIRS-CrIS Tropical SNO Brightness Temperature Spectra parameterized by BT 900 Scene Temp (Manning)

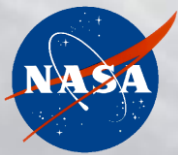
BT diff

Mean BT Spectra



Copyright 2018  
California Institute of Technology  
Government sponsorship acknowledged

AIRS Calibration Status  
AIRS Science Team Meeting  
April 25-27 2018 Pasadena CA

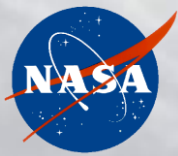


National Aeronautics and  
Space Administration

Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

# L1B Calibration Coefficients Areas of Investigation

- There are some known issues which are being worked
  - *temperature dependence of differences*
  - *optimum calibration of the A/B channels. There is currently one set of coefficients for each channel's A/B detector pair*
  - *there are some unusual patterns at temperatures below 210K in the SW channels*
  - *How to best deal with the spectral calibration*
- At the 100 mK level it is very difficult find to verify that any changes in the L1B calibration coefficients produce a more accurate calibration.
- That being said ....

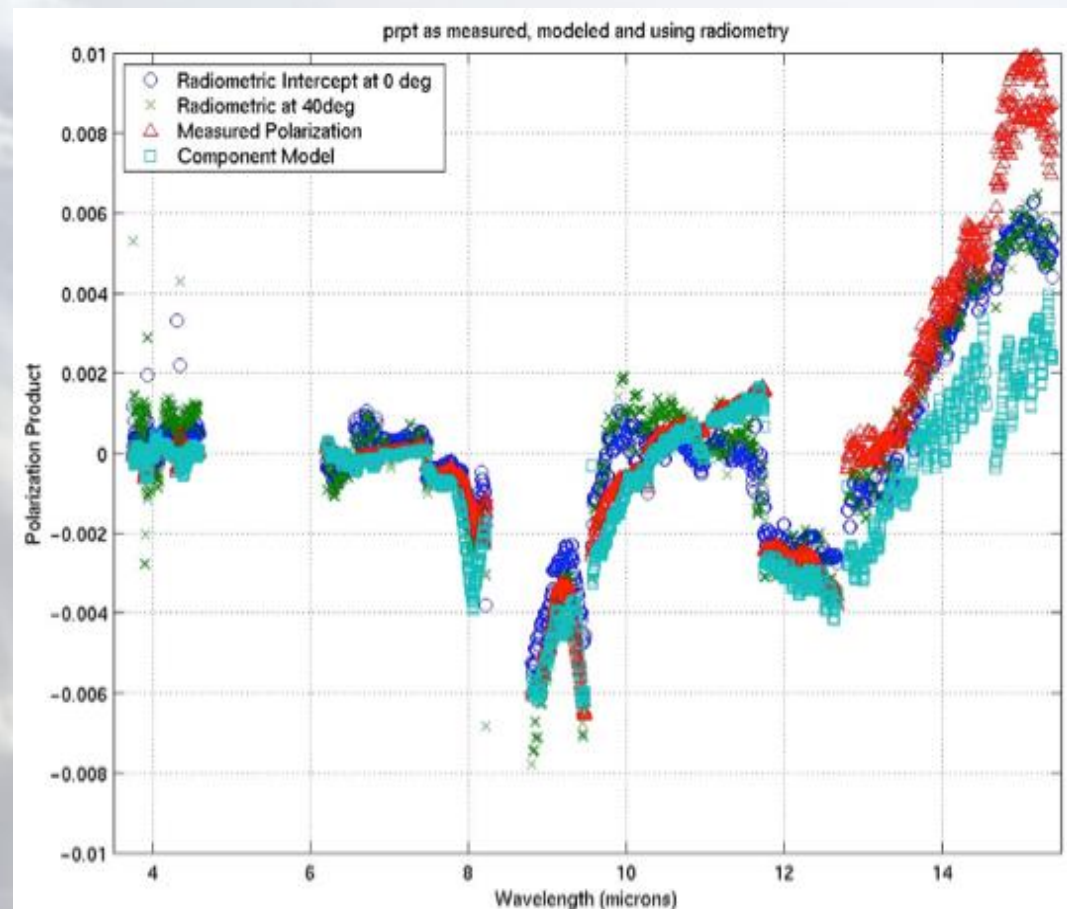


National Aeronautics and  
Space Administration

Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

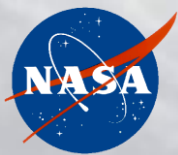
## Lunar roll data set

- V5 polarization parameters were derived from pre-flight measured and modeled polarization.
- The MODIS lunar roll series provides another, new data set which can be used to improve our understanding of the polarization, as it allows a view of space in scene view footprints 88-90.



Polarization product estimated 3 ways:  
Measured, RVS 0&40, Component Model (Pagano)





National Aeronautics and  
Space Administration

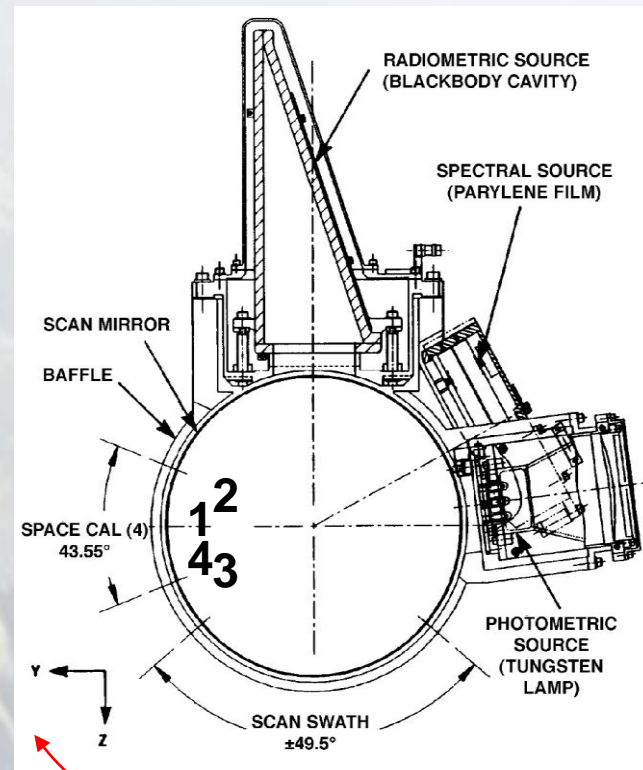
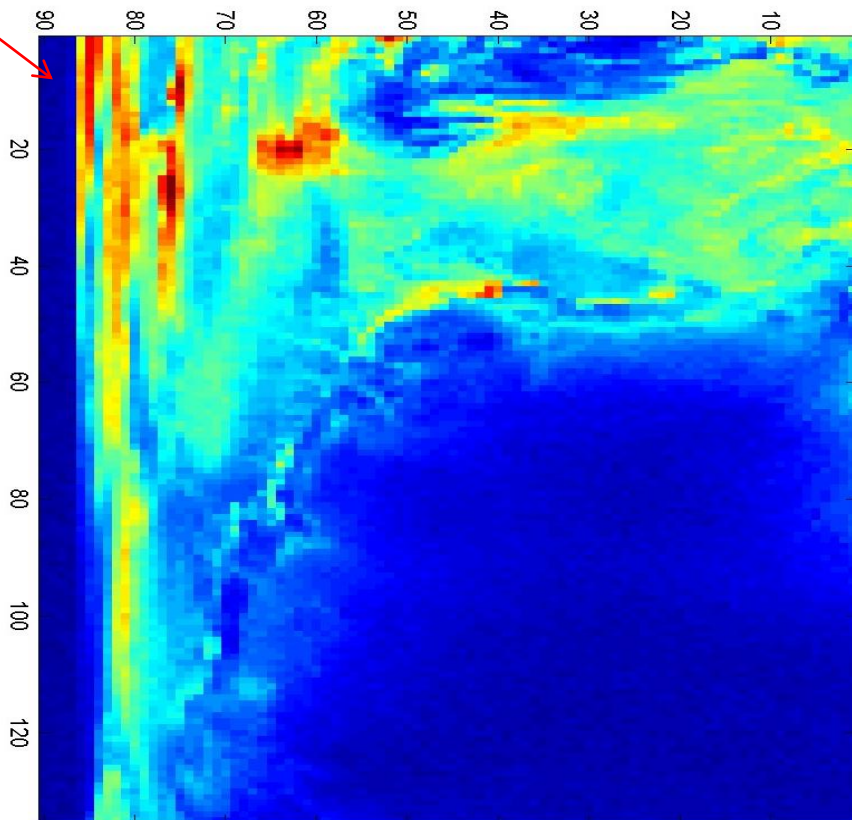
Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

## Lunar roll data set (cont)

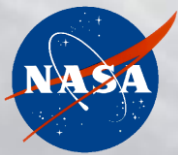
Space

Crosstrack Footprint

Scan number



Roll  
Direction



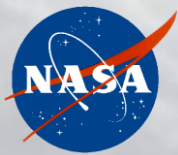
## Lunar Roll History, sorted by magnitude

Aqua MODIS Lunar Calibration Roll (MLC) History									
Roll rank	Date	DOY	Slew Out Start Time	Slew Complete	Roll Angle	Slew Return Start Time	Slew Complete	Calibration Time	NOTES
	(mm/dd/yy)		(hh:mm:ss)	(hh:mm:ss)	(degrees)	(hh:mm:ss)	(hh:mm:ss)	(mm:ss)	
1	10/16/02	289	14:11:38	14:21:28	-20.0510	14:29:58	14:39:48	08:30	G144 complete
2	07/10/11	191	21:12:52	21:23:41	-20.0000	21:32:11	21:43:00	08:30	Scan profile test during this slew
3	07/06/06	187	13:35:43	13:46:30	-19.9065	13:55:00	14:05:47	08:30	G138 complete
4	08/17/13	229	0:30:29	0:41:15	-19.8433	0:49:45	1:00:31	08:30	G007 complete
5	07/02/09	183	5:02:47	5:13:32	-19.7496	5:22:02	5:32:47	08:30	G053 return slew last 1:23
6	10/13/05	286	16:06:53	16:17:36	-19.6645	16:26:06	16:36:49	08:30	G163 slew stops 11 sec in
7	09/18/10	261	9:32:54	9:43:32	-19.3639	9:52:02	10:02:40	08:30	G97 3:53 min in slew. G98 4:37
8	07/19/02	200	21:00:24	21:10:02	-19.3540	21:18:32	21:28:10	08:30	G212 complete
9	08/06/14	218	20:04:13	20:14:50	-19.2678	20:23:20	20:33:57	08:30	G203 return slew starts last 5 sec
10	07/18/13	199	20:04:45	20:15:20	-19.1540	20:23:50	20:34:25	08:30	G203 complete
11	08/13/16	226	21:30:02	21:40:33	-18.9155	21:49:02	21:59:33	08:29	G217 Complete
12	08/25/15	237	16:46:15	16:56:41	-18.6407	17:05:11	17:15:37	08:30	G170 complete

Over 140 roll maneuvers throughout mission so far.

Rolls above 19 degrees desired for uncontaminated footprints in scene view.

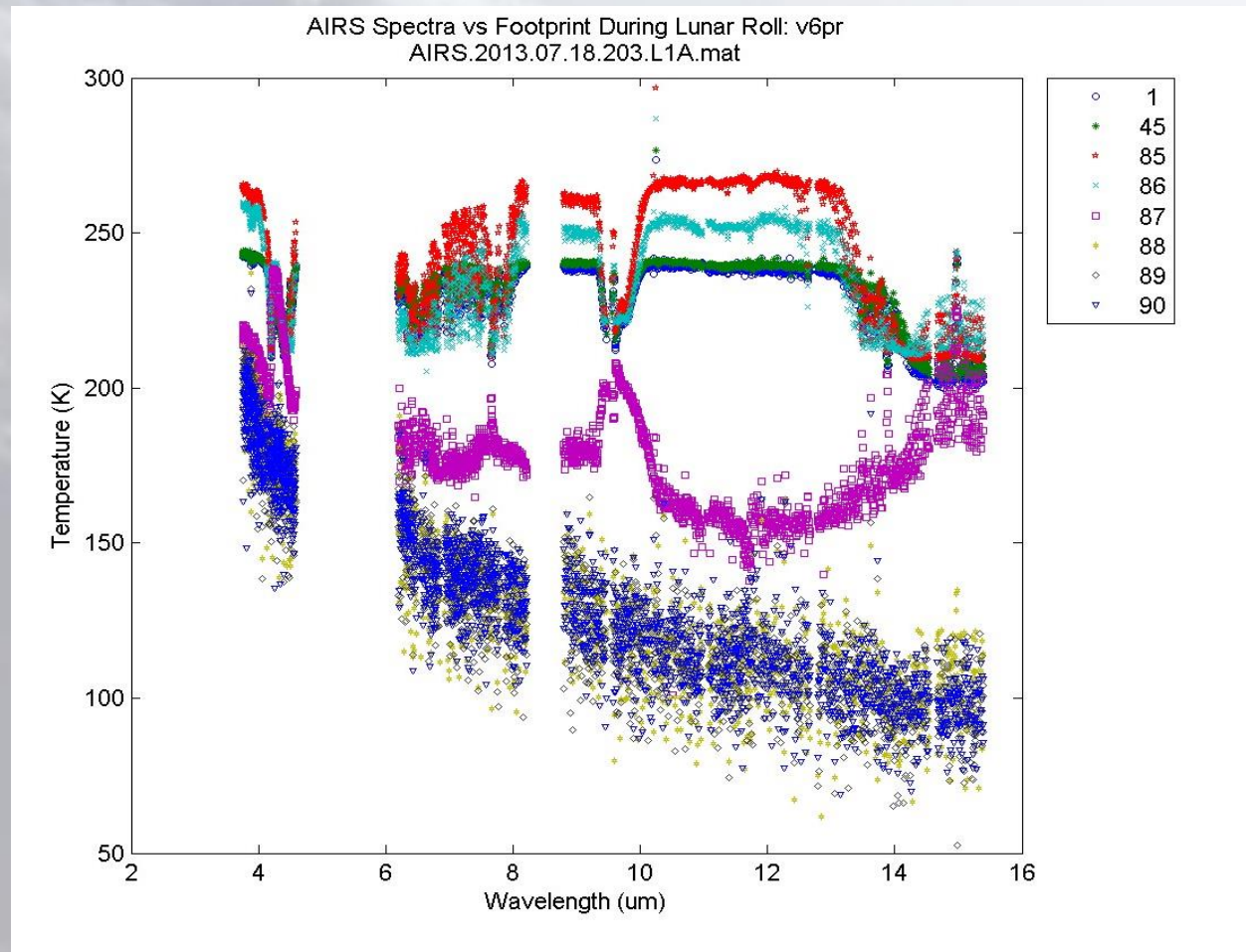
Examined rolls 1, 3, 4, 6, 9, 10



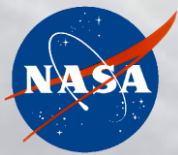
National Aeronautics and  
Space Administration

**Jet Propulsion Laboratory**  
California Institute of Technology  
Pasadena, California

# Lunar Roll Test Spectra show good space views in scene footprints 88-90





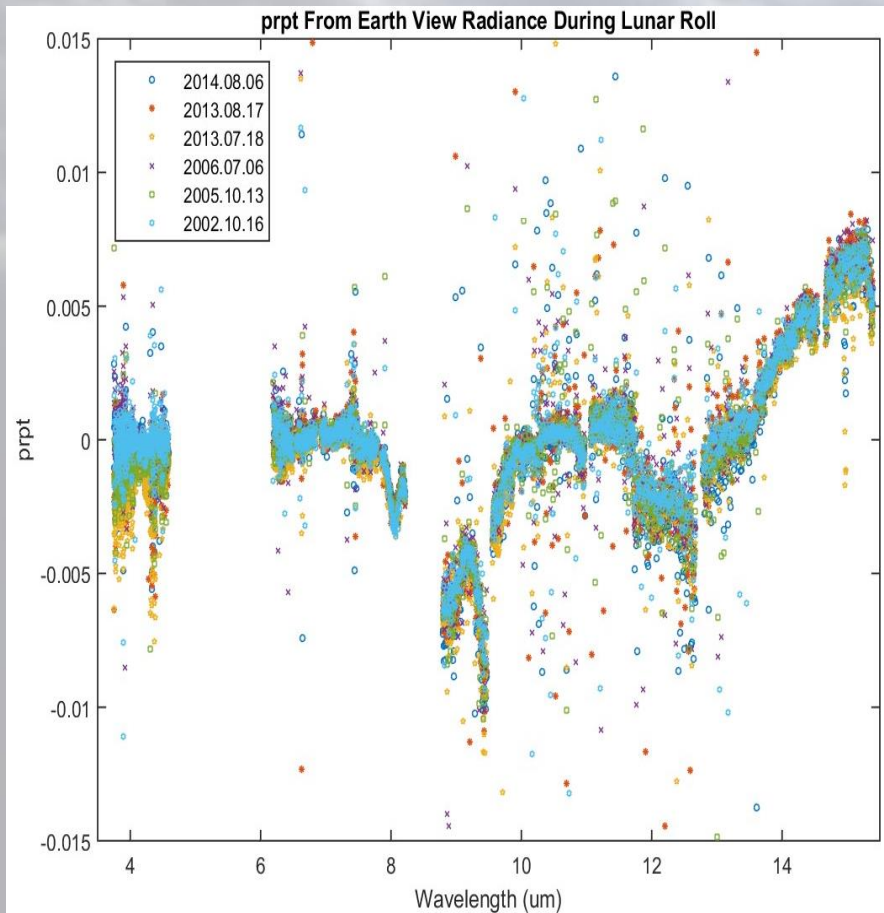


National Aeronautics and  
Space Administration

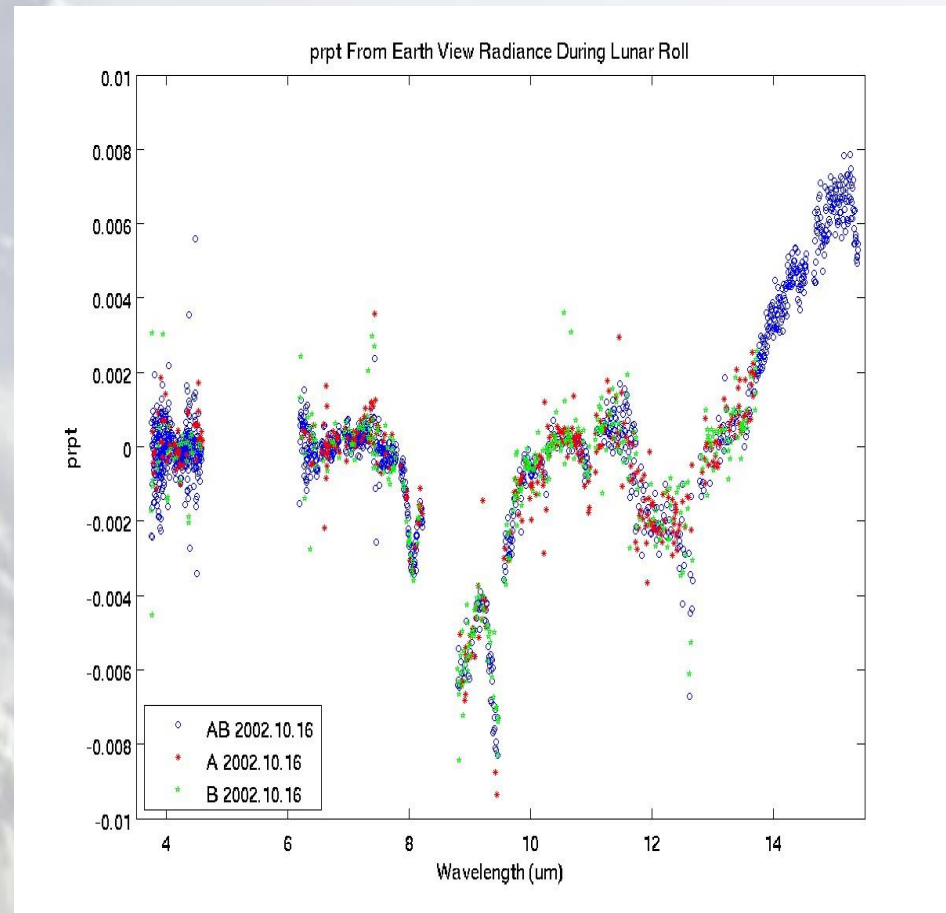
Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

# Polarization product PrPt

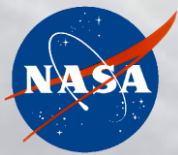
## PrPt for 6 selected rolls



## PrPt for 1 roll separated by channel A/B state





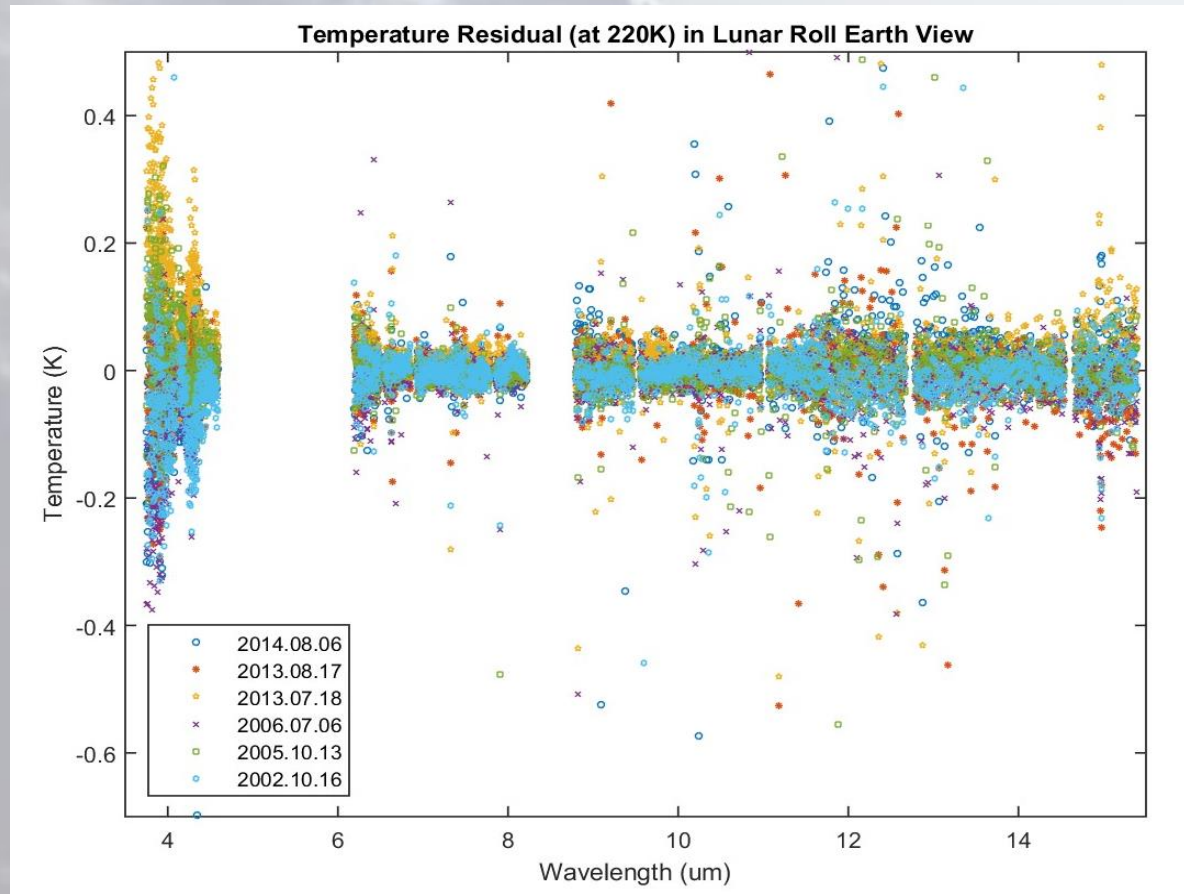


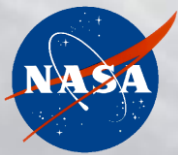
National Aeronautics and  
Space Administration

**Jet Propulsion Laboratory**  
California Institute of Technology  
Pasadena, California

# Closure test shows new $p_r p_t$ averaged over all tests shows low residuals for each test

## Residual at 220 K



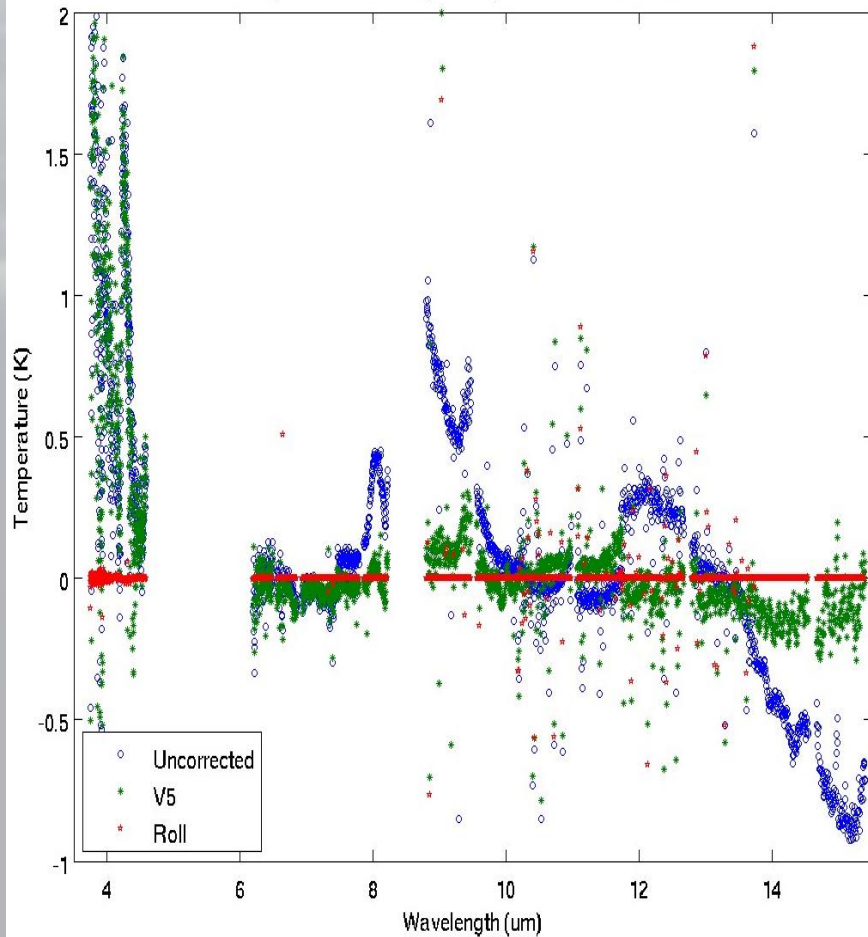


National Aeronautics and  
Space Administration

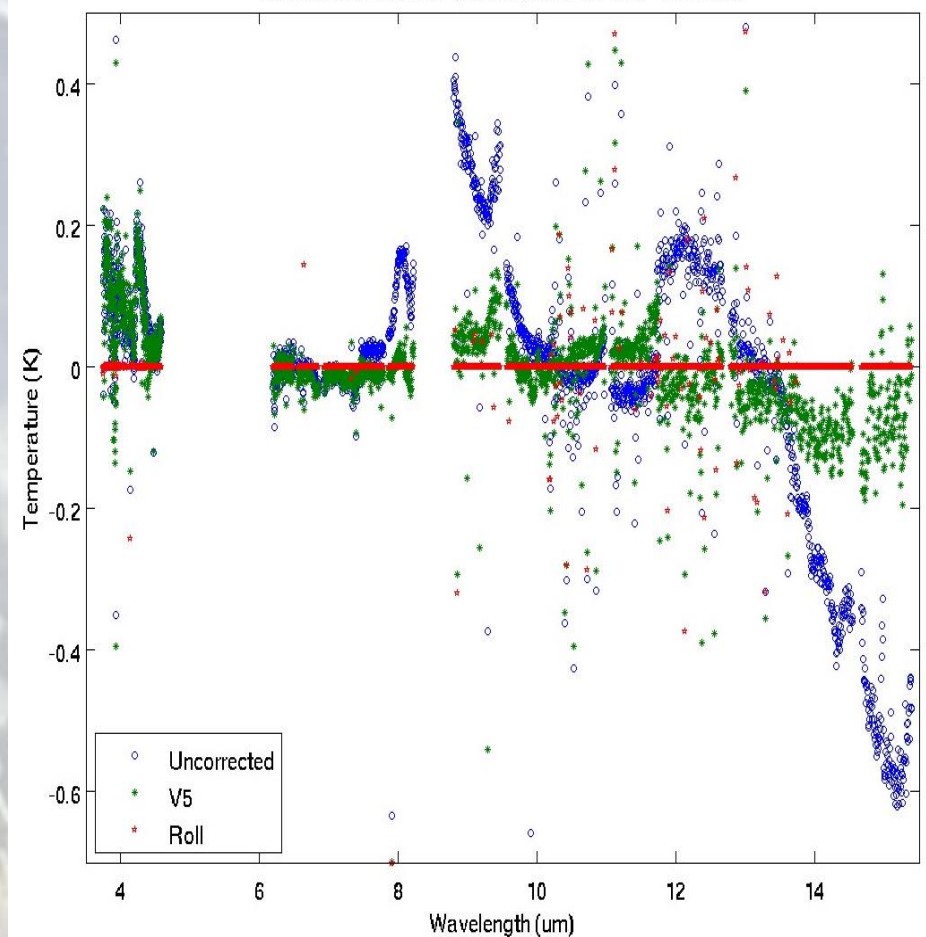
Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

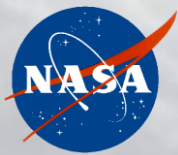
## Residuals at 190 and 220 K (averaged over all tests)

Temperature Residual (at 190K) in Lunar Roll Earth View



Temperature Residual (at 220K) in Lunar Roll Earth View





## Level 1C

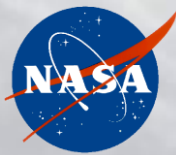
- **First version is available—does cleaning and gap filling well**
  - *At the GES DISC they maintain a rolling 1-month of products*
- **Improvements being considered**
  - *spectral model from Strow*
  - *spectral resampling*
  - *improve buddy first-pass replacement*
  - *improve outlier detection*
  - *estimate of fill value “goodness”*
  - *better PCA training set from UMBC*
  - *better Cij metrics/handling (PC 100 current, PC 20, MODIS, other?)*



## Summary

- **L1B PGE improvements (e.g., precision) are planned**
- **Calibration coefficients – there is a path to a physics based improvement of the coefficients (i.e., not based on comparisons to other instruments or earth scene/model references). Also has potential for time dependent correction.**
- **Much work to be done to verify/validate improvement**
- **L1C is available, improvements in the works**
- **Comments/questions? Wishlist items for future release(s)?**

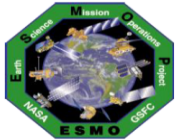




National Aeronautics and  
Space Administration

Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

14+ years down, 5+ to go



## Fuel Usage: Actual & Predicted (February 2016)

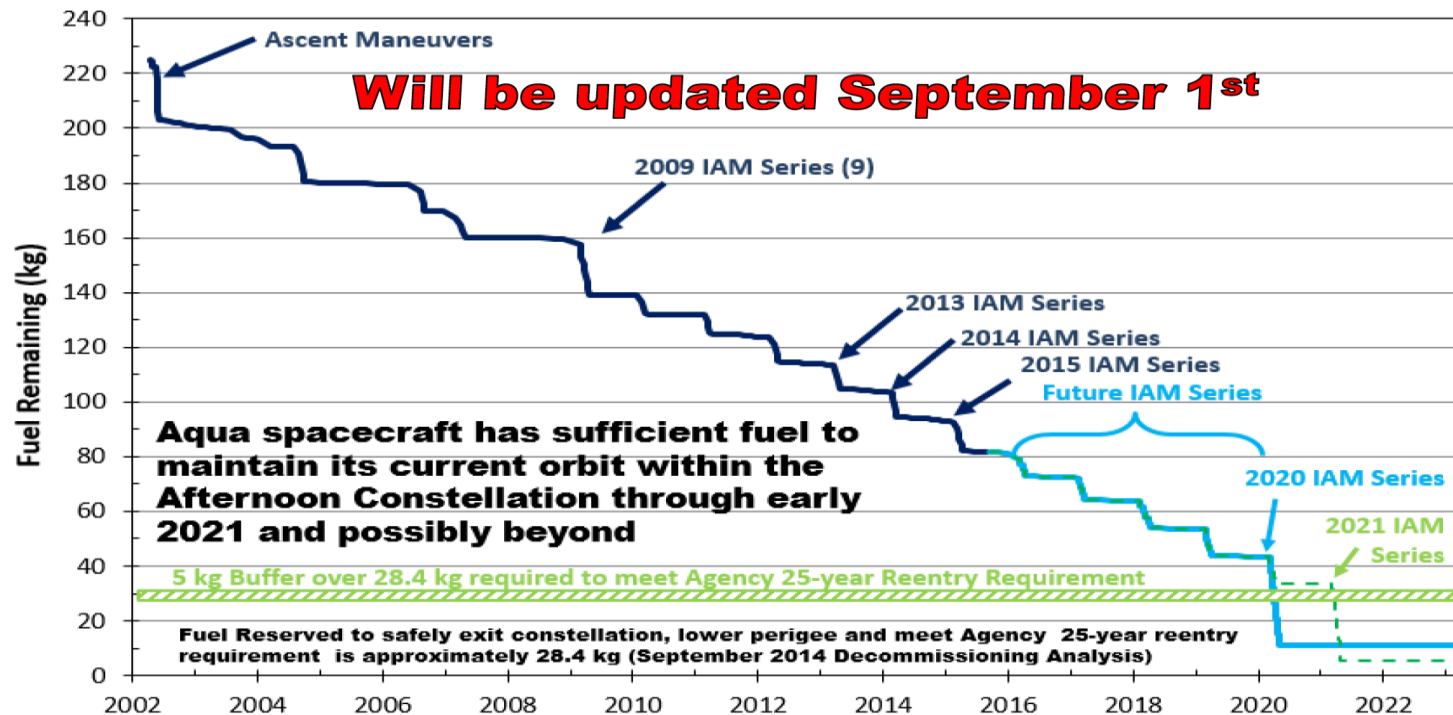
anomaly

Previous

Next



----- Aqua Definitive Data ----- Aqua Predicted ----- Constellation Exit



9/1/2016

Science Team Teleconference

11